A WEIGHT-OF-EVIDENCE APPROACH TO PROJECTING LAND-USE CHANGE AND RESULTING ECOLOGICAL VULNERABILITY

A Research Demonstration across the Mid-Atlantic Region

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in collaboration with:
U.S. Forest Service
U.S. Geological Survey
Oak Ridge National Laboratory
Rutgers University
University of California-Santa Barbara
University of Maryland
University of North Carolina

U.S. EPA Regional Manager's Question:

Where Will Projected Land-Use Change Compromise the Sustainability of Ecological Resources and Quality of Life in the Mid-Atlantic Region?

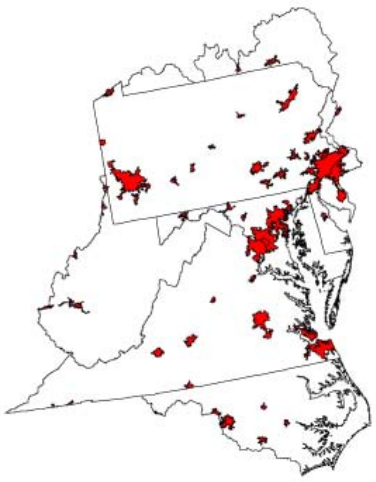
URBANIZATION
Is the Most Rapidly Increasing Driver of Environmental Degradation in the Mid-Atlantic Region.

Yet, Meaningful Projections Require Understanding and Forecasting Human Behavior at Scales that are Relevant to Landowner Decisions.

Examples of
Direct and Indirect Results of Urbanization:

- Habitat Conversion / Fragmentation
- Polluted / Excessive Runoff
- Polluted Air and Deposition
- Increased Invasive Species
- Longer Commute Times
- Overuse of Natural Areas ...

ALTERNATIVE FUTURES OF LAND-USE CHANGE:
A Scaled Approach to Evaluating Risk

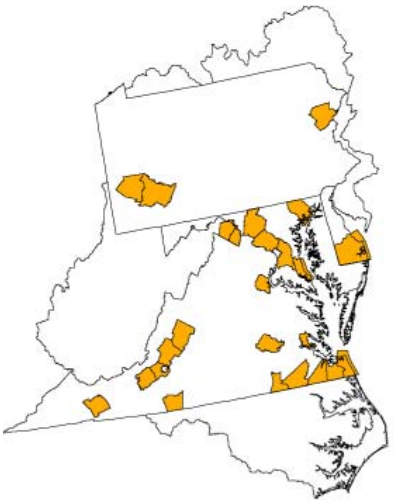


1 - Region-Wide Analyses

- Urban Growth GIS Model
- Resource Economics Model
- Land Demand from Pop. Projections
- Development Plans
- Agent-Based Model of Lifestyle Choice

2 - Large-Scale Sensitive Resources:

- Contiguous Forest
- Sensitive Species Richness
- Exotic Species Richness
- T&E Fish and Mussels

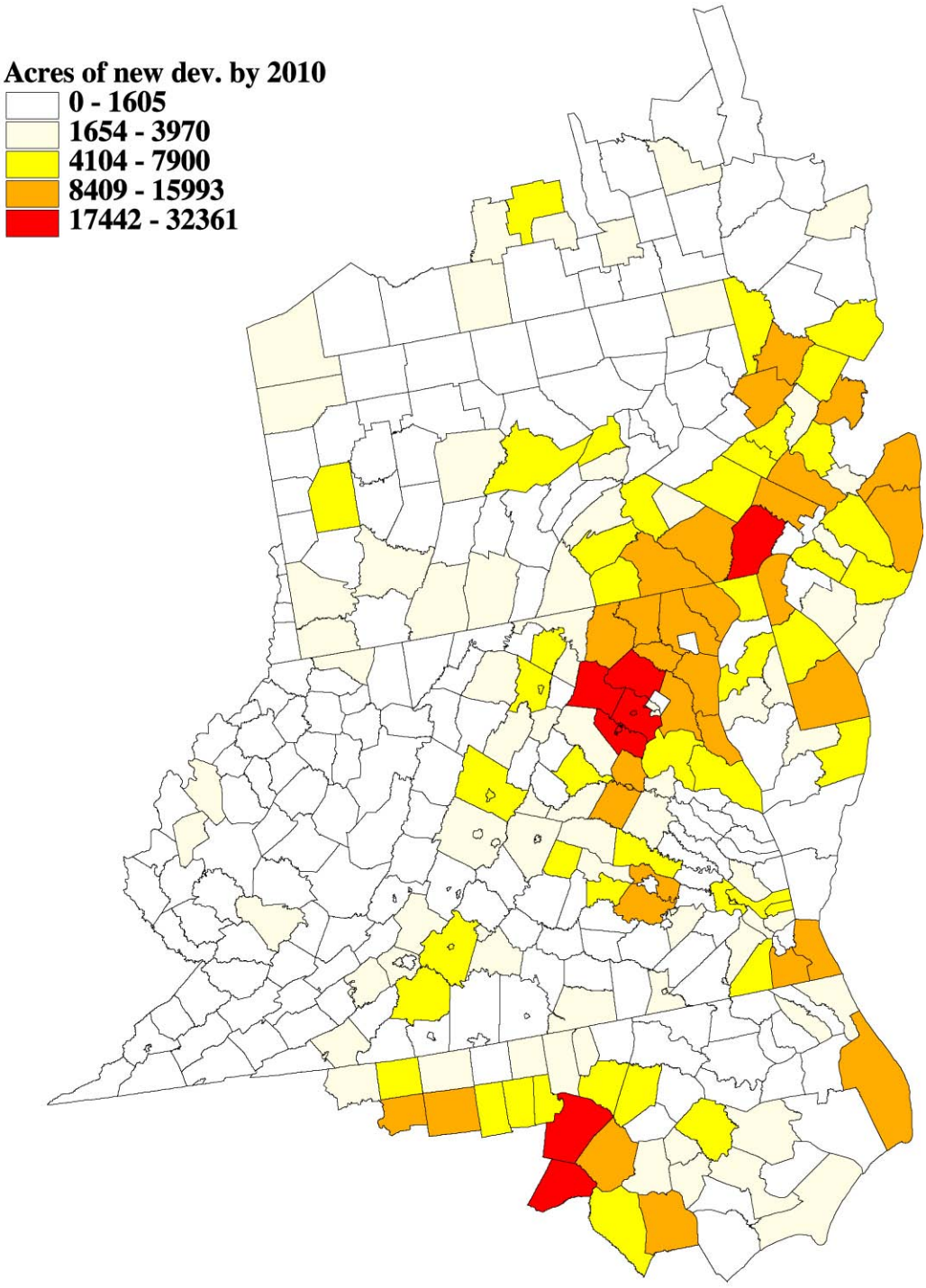


3 - High-Resolution Land-Use Models

- Integrated Transportation/ Land-Use Models
- Build-Out Analyses
- Land Valuation Analysis
- Higher-Resolution Versions of Regional Models

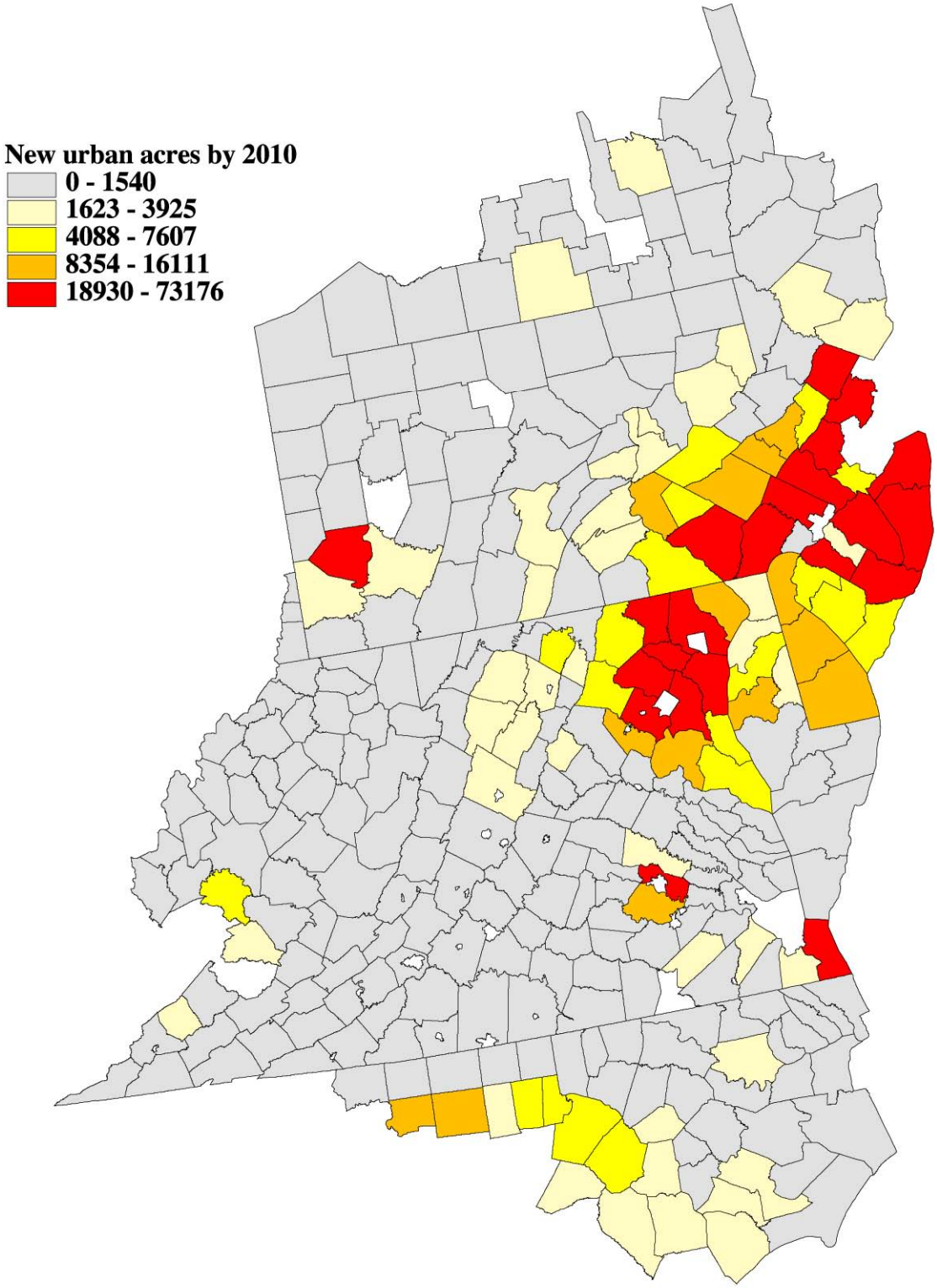
PROJECTED RESIDENTIAL LAND DEMAND TO 2010

From State Population Projections



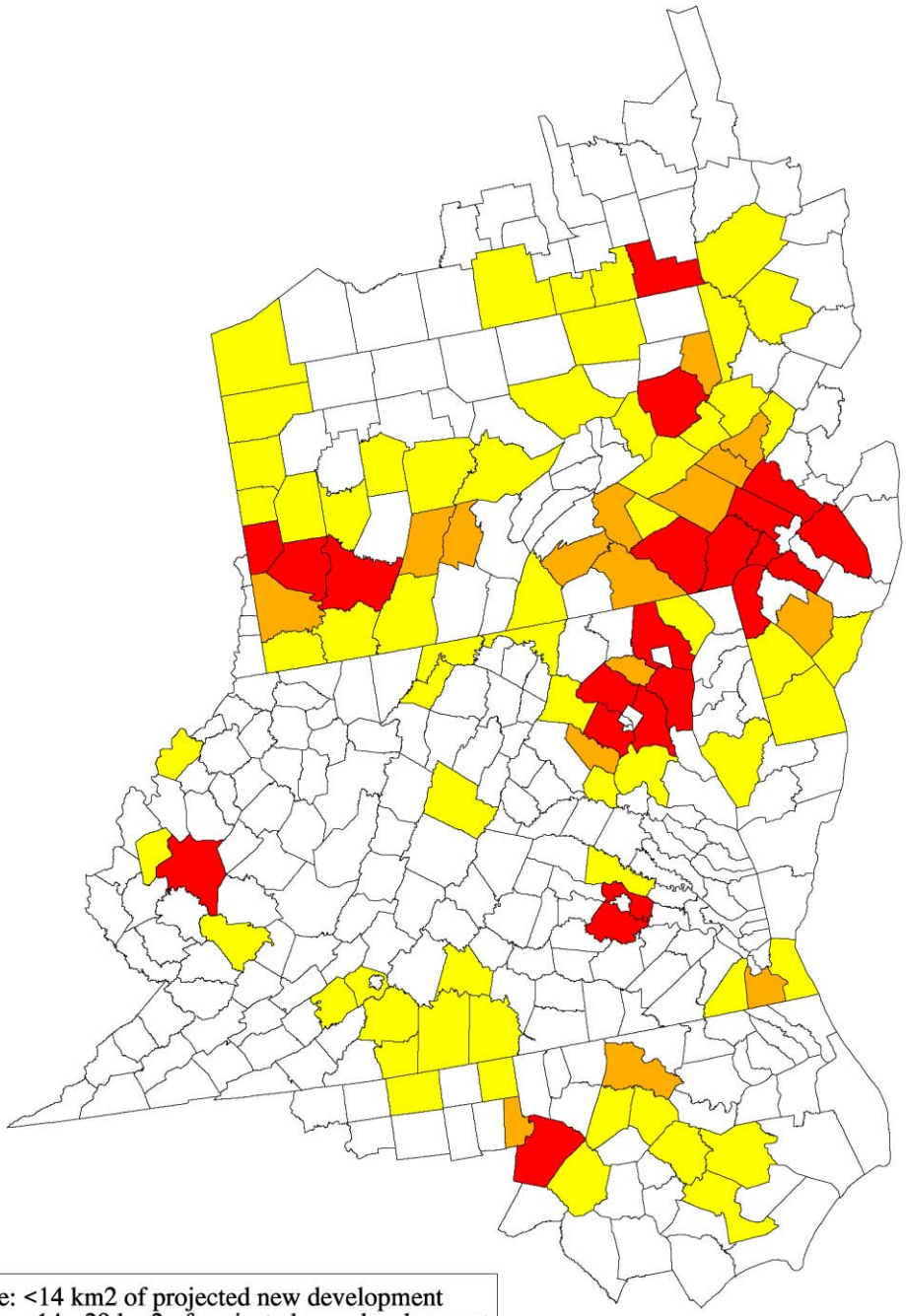
Analysis by Sandy Bird, U.S. EPA (Athens, GA)

PROJECTED CHANGE IN URBAN ACREAGE to 2010
from Resource Economics Model



Analysis by Dave Wear, USDA Forest Service, and Ron Matheny, U.S. EPA (Research Triangle Park, NC)

RESULTS OF URBAN GROWTH MODEL TO 2010 in MAIA

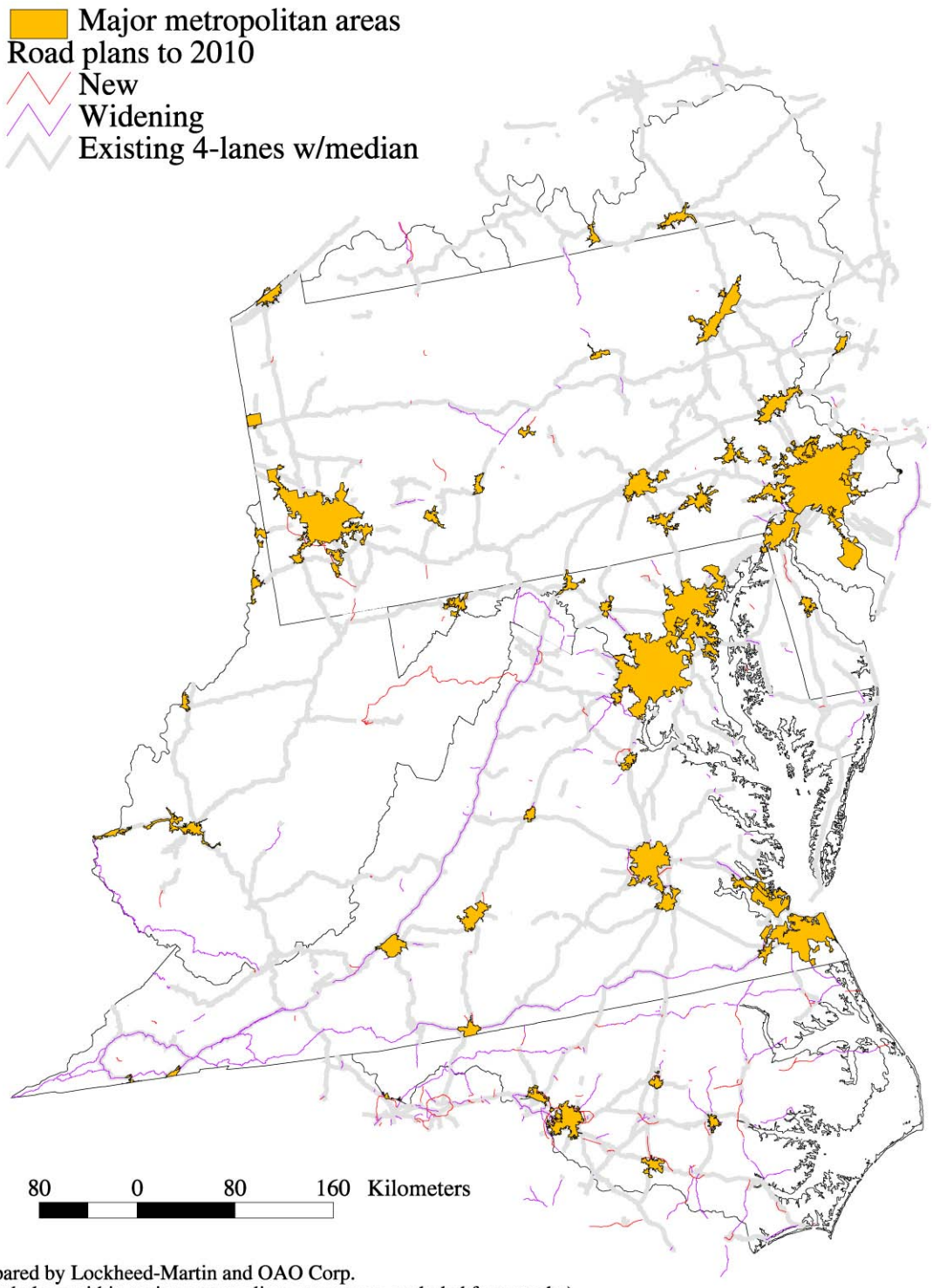


White: <14 km2 of projected new development
Yellow: 14 - 29 km2 of projected new development
Orange: 30 - 44 km2 of projected new development
Red: >44 km2 of projected new development

100 0 100 200 Kilometers

Developed by Keith Clarke, UC-Santa Barbara.
Applied to MAIA by William Acevedo et al.,
US Geological Survey. (1-km pixel resolution
of model is shown aggregated to county level.)

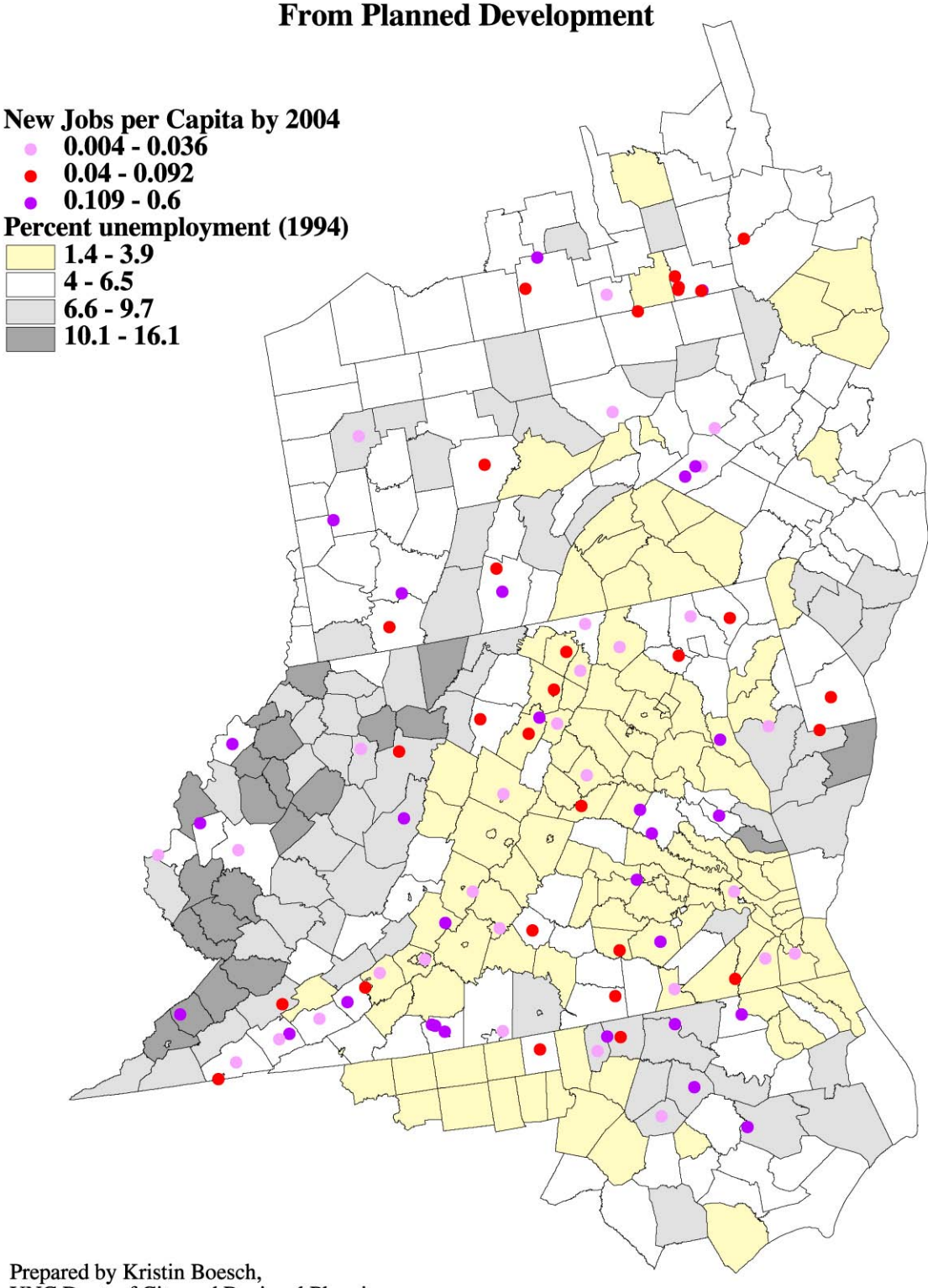
PLANNED HIGHWAY CONSTRUCTION to 2010



Prepared by Lockheed-Martin and OAO Corp.
(Road plans within major metropolitan areas were excluded from study.)

PROJECTED NEW JOBS PER CAPITA to 2004
(against unemployment rates)

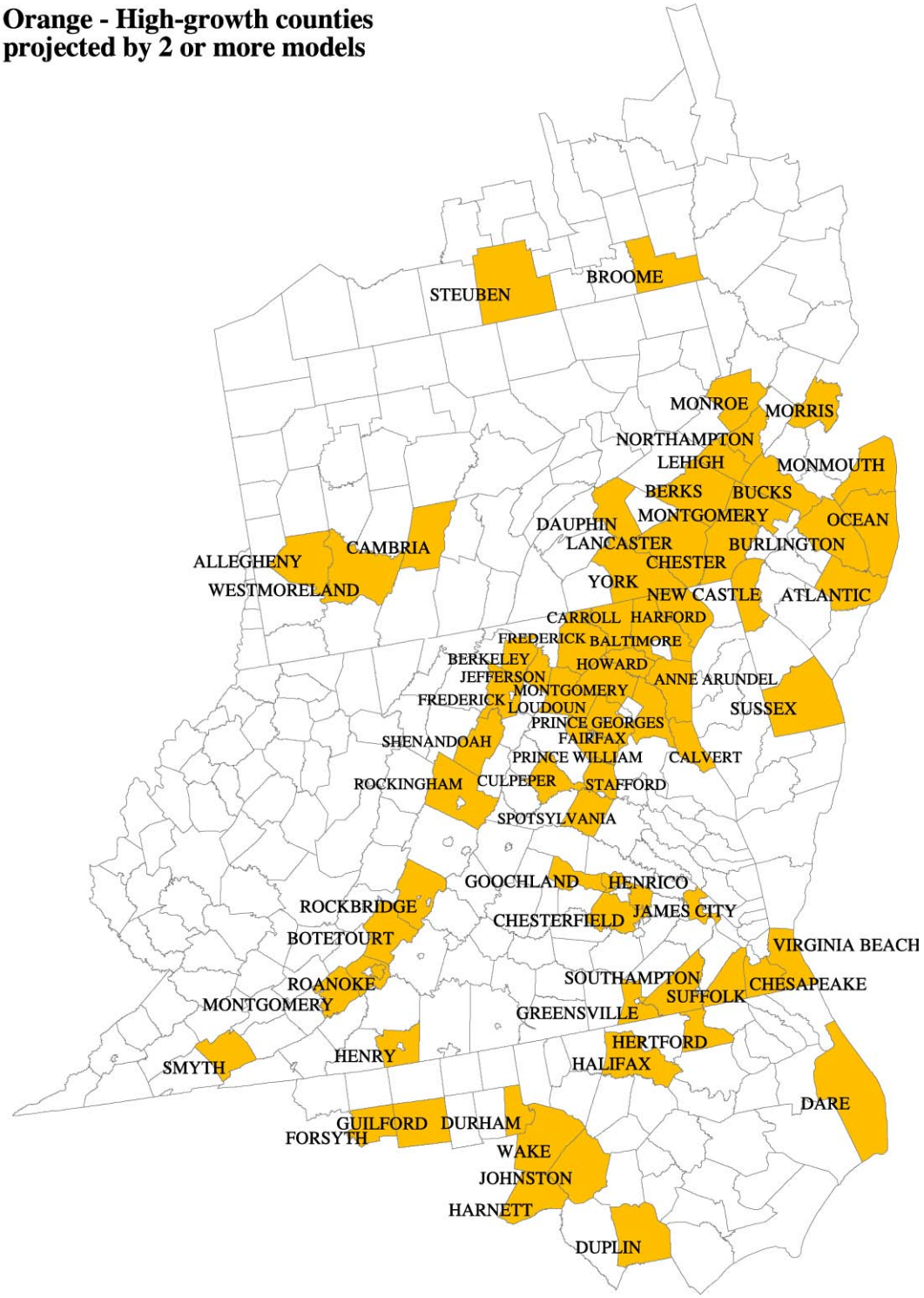
From Planned Development



Prepared by Kristin Boesch,
UNC Dept. of City and Regional Planning

MAIA Counties with Greatest Development Pressure by 2010?

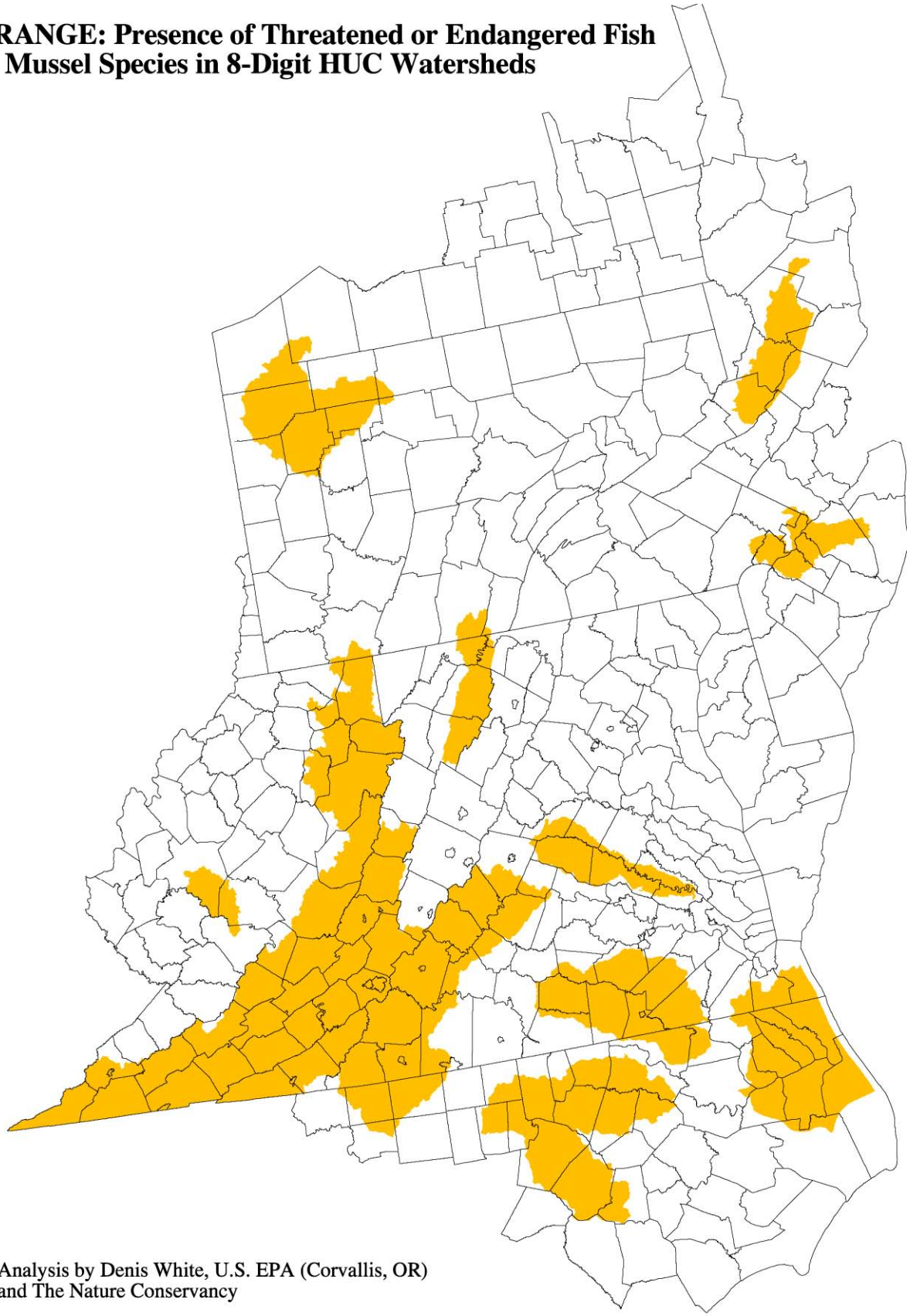
Orange - High-growth counties projected by 2 or more models



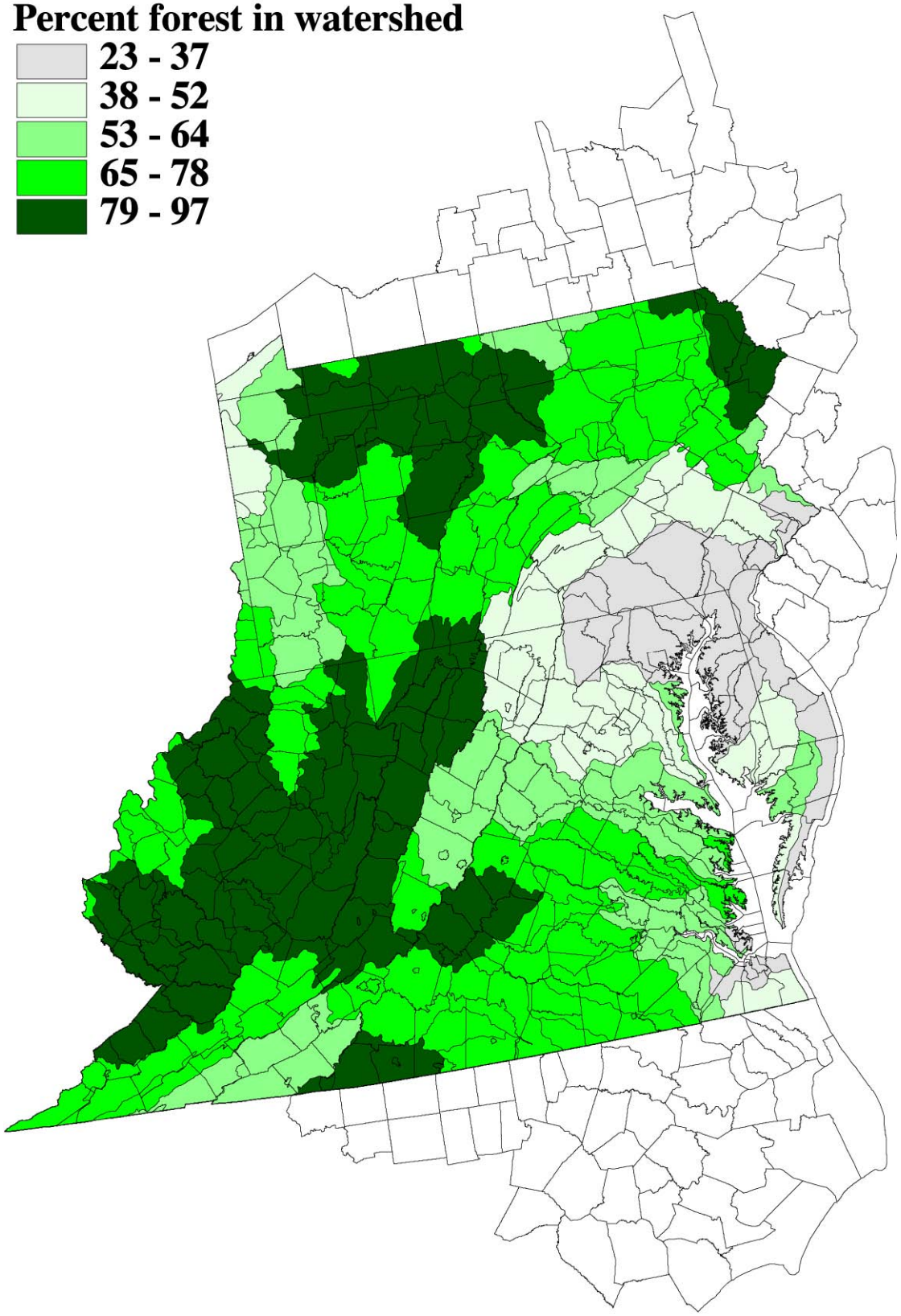
L. Jackson, 6/16/00

THREATENEND OR ENDANGERED FISH AND MUSSEL SPECIES

ORANGE: Presence of Threatened or Endangered Fish or Mussel Species in 8-Digit HUC Watersheds

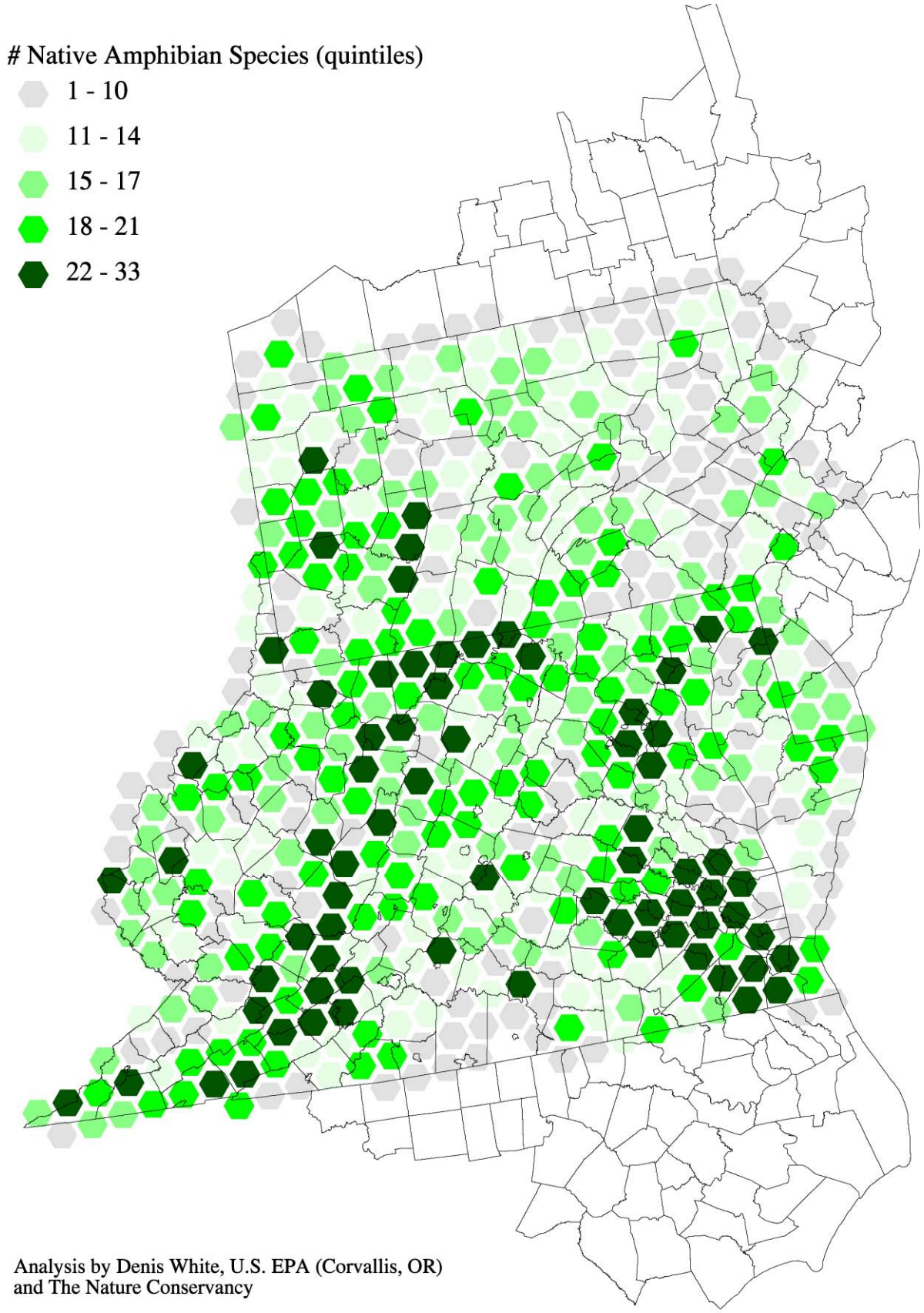


Analysis by Denis White, U.S. EPA (Corvallis, OR)
and The Nature Conservancy



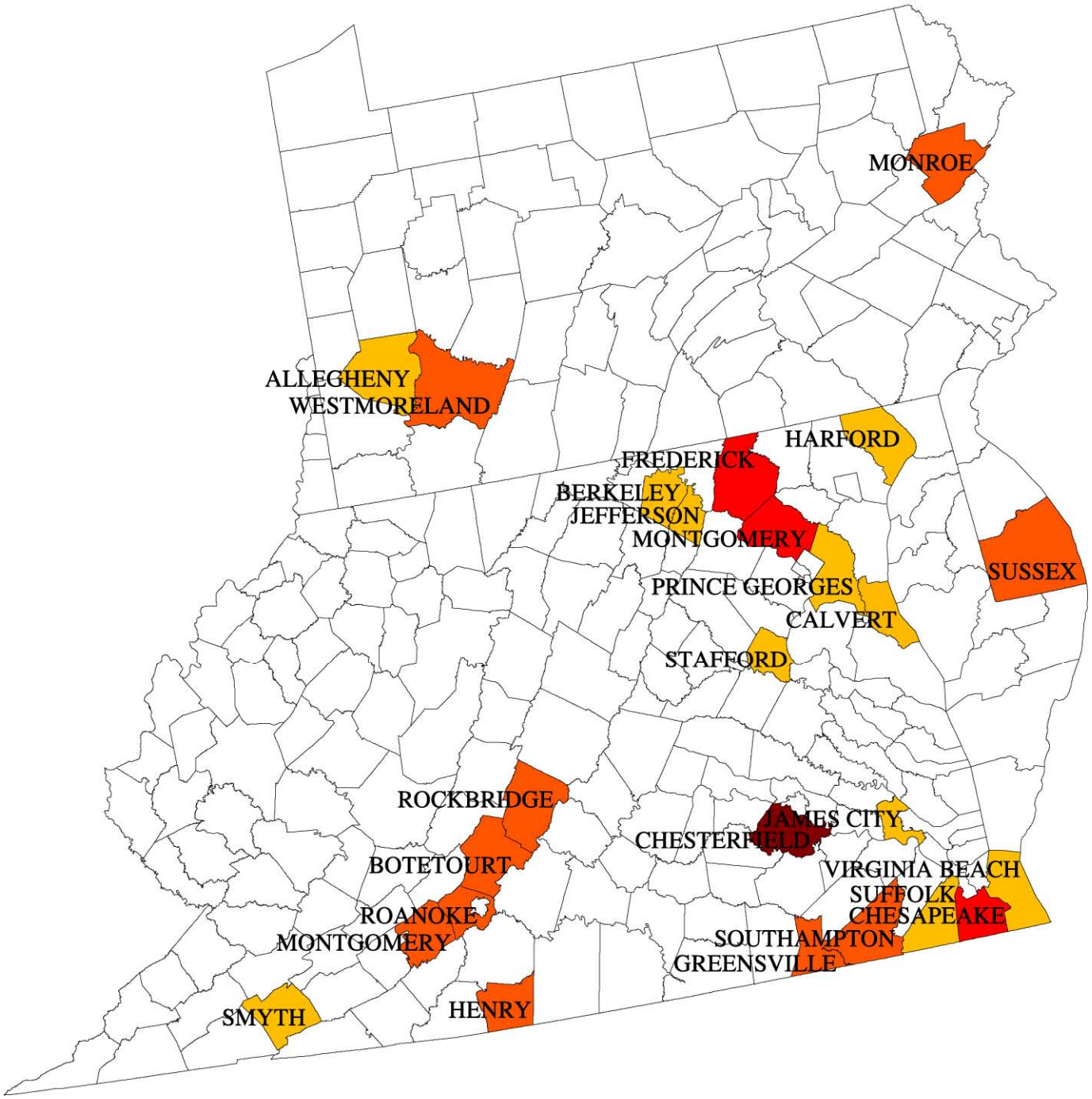
Source: Jones et al. 1997

SPECIES RICHNESS - NATIVE AMPHIBIANS



Analysis by Denis White, U.S. EPA (Corvallis, OR)
and The Nature Conservancy

Region III Counties at Greatest Environmental Risk from Urbanization by 2010



U.S. EPA Technology Transfer Reports:

I.

PROJECTING LAND-USE CHANGE:

A Summary of Models for Assessing the Effects of Community Growth and Change On Land-Use Patterns

II.

PROJECTING ENVIRONMENTAL IMPACTS FROM LAND-USE CHANGE:

Summaries of Selected Models

PROJECTING LAND-USE CHANGE

FORMAT

- **Descriptions of 22 leading models**
- **Comparative matrices**

AUDIENCE

- **Planners, to identify potential tools**
- **Researchers, to focus on gaps & linkages**

AUTHORS

- **Federal / Academic / Consultant Group of Modelers and Community Liaisons**

QUALITY CONTROL

- **Information validated by developers**
- **Reviewed by planners for utility**

MODELS INCLUDED IN EPA REPORT

1. What If?
2. MEPLAN
3. DRAM/EMPAL
4. Emmi's Markov Model of Residential Vacancy Transfer
5. Smart Growth INDEX
6. INDEX
7. California Urban Futures Model I
8. California Urban Futures Model II
9. California Urban and Biodiversity Analysis
10. SLEUTH
11. METROSIM
12. UGROW
13. UPLAN
14. UrbanSim
15. Land Transformation Model
16. TRANUS
17. Growth Management Simulation Model
18. Smart Places
19. DELTA
20. IRPUD
21. LUCAS
22. SAM-IM

GENERAL FACT SHEETS

- Brief Overview of Purpose
- Requisite Resources
- Land Uses Addressed
- Questions Answered
- Information Needed to Run Model
- Strengths and Limitations
- Case Studies & Application Sites
- Contact Information & References

TECHNICAL FACT SHEETS

- Spatial Resolution and Extent
- Temporal Resolution and Extent
- Input Pre-Processing Requirements
- Model Assumptions
- Setting Parameters
- Comparing Scenarios
- Output Post-Processing Requirements

COMPARATIVE MATRICES

- Requisite Technical Expertise
- Necessary Hardware and Software
- Land-Use Categories Addressed
- Impacts of Community Decisions on Land-Use Patterns
  - transportation
  - zoning
  - master plans
  - taxes
  - subsidies
- Impacts of Land-Use Patterns on Community Characteristics
  - travel demand
  - infrastructure costs
  - tax revenue
  - nutrient loading
  - greenhouse gases
- Operational / Calibration Characteristics

PURCHASE COST

Free	$1 – 5,000	$5,001 – 10,000	$10,000+	Contact Developer
LTM LUCAS Markov SLEUTH Smart Growth INDEX® UGrow² UPLAN UrbanSim	What if?	TRANUS	DRAM/EMPAL INDEX® MEPLAN METROSIM SAM-IM	CUF-1 CUF-2 CURBA DELTA GSM IRPUD Smart Places

AVAILABILITY OF MODEL SUPPORT

Model	Written Documentation	Website	Training
MEPLAN	✓	✓	✓
METROSIM	✓		✓
SAM-IM	✓		✓
SLEUTH	✓	✓	
Smart Places	✓	✓	
TRANUS²	✓	✓	✓
Ugrow			✓
UPLAN	✓		
UrbanSim	✓	✓	
What if?	✓	✓	✓

REQUISITE TECHNICAL EXPERTISE

Model Name	Target User Group	Technical Expertise for Usage (1 [none] – 3 [extensive])	Consultant Expertise Required?	Computer Skills for Usage (1 [general] - 3 [extensive])
CUF-1	Non-technical community planning participants	2	No	3
DELTA	Politicians, policy makers, planners	3	Yes	1
INDEX	Community planning participants	3	Yes	2
Markov	Demographers, residential planners, developers, policy makers	1	No	2
METRO SIM	Planners, transportation engineers, economists	1	Yes	1
SLEUTH	Academic and government researchers, planners	2	No	2
TRANUS	Transportation and land use planners and academics	2	No	2
What if?	Non-technical community planning participants	2	No	1

MODEL UTILITY AND INTEGRATION

Model Name	Relative Ease of Linking to Other Models (1 [easy] – 3 [hard])	Relative Ease of Transferring to Other Locations (1 [easy] – 3 [hard])	Number of Locations to Which Model Has Been Applied
CUF-1	2	2	1
DELTA	2	2	6
DRAM/ EMPAL	**2**	**2**	**40+**
INDEX	2	2	>10
SLEUTH	2	2	13
LUCAS	**3**	**2**	**1-5**
Markov	2	2	>10
METROSIM	1–2	1	6
SLEUTH	2	2	13
TRANUS	2	1	35+
UGrow	**3**	**2**	**6**
What if?	2	2	3

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